AD-A063 913 ARINC RESEARCH CORP ANNAPOLIS MD F/G 10/1
DESTROYER ENGINEERED OPERATING CYCLE (DDEOC). SYSTEM MAINTENANC--ETC(U)
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LEVEL II

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DESTROYER ENGINEERED OPERATING CYCLE (DDEOC)

System Maintenance Analysis

FF-1052 CLASS COMBUSTION AIR SYSTEM

SMA 103-251

REVIEW OF EXPERIENCE

December 1976

Prepared for
Director, Escort and Cruiser
Ship Logistic Division
Naval Sea Systems Command
Washington, D. C.
under Contract N00024-76-C-4319

ARINC RESEARCH CORPORATION

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE — READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER 1646-03-1-1566	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Destroyer Engineered Operating Cylce System Maintenance Analysis		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Craig P. Beyers		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARINC Research Corporation 2551 Riva Road Annapolis, Maryland 21401		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Director, Escort and Cruiser Naval Sea Systesm Command Washington D.C.		12. REPORT DATE Dec 76
		13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) same as above		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

UNCLASSIFIED-UNLIMITED

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report, the Review of Experience, documents the historical maintenance experience for the FF-1052 Class Combustion Air System, presents an analysis of the problems encountered, and reccommends actions to improve system material condition. It has been developed for NAVSEA 934X, the sponsor of the Destroyer Engineered Operating Cycle (DDEOC) Porgram, under Navy Contract N00024-76C-4319

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by

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FOREWORD

This report, the Review of Experience, documents the historical maintenance experience for the FF-1052 Class Combustion Air System, presents an analysis of the problems encountered, and recommends actions to improve system material condition. It has been developed for NAVSEA 934X, the sponsor of the Destroyer Engineered Operating Cycle (DDEOC) Program, under Navy Contract N00024-76-C-4319.

SUMMARY

The Destroyer Engineered Operating Cycle (DDEOC) Program goal is to effect an early improvement in the material condition of ships, at an acceptable cost, while maintaining or increasing their operational capability during an extended operating cycle. In support of this goal, System Maintenance Analyses (SMAs) are being conducted for selected systems and subsystems of designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the FF-1052 Class Combustion Air System.

An ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessment of the significance and consequence of identified problems. Additionally, the report recommends specific actions which will prevent or reduce the impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The Combustion Air System ROE included an analysis of all available maintenance data sources. The documented maintenance experience of the system was reviewed through analysis of Maintenance Data Collection Subsystem (MDCS) data, Casualty Reports (CASREPTs), and system overhaul records. Initial findings from these sources were correlated with Planned Maintenance Subsystem (PMS) requirements, system alterations, and system technical manuals to identify maintenance problems. Ship surveys were conducted and discussions were held with appropriate technical codes in order to validate identified problem areas, identify undocumented maintenance problems, and determine the status of current and planned actions affecting the Combustion Air System. All findings were evaluated, and appropriate conclusions were developed. Recommendations were then formulated to implement existing and newly defined corrective actions to minimize the occurrence of identified problems and their impact on the extended operating cycle.

The major conclusions and recommendations resulting from the Review of Experience for the Combustion Air System are summarized as follows:

- The Combustion Air System is capable of operating throughout a 54-month extended operating cycle without an overhaul.

- It is expected that the Forced Draft Blowers will require repair during the Baseline Overhaul. However, no requirement for Class B overhaul of the Forced Draft Blowers is foreseen. The repairs necessary to correct specific equipment problems (Class C Repairs) will be identified during inspections.

- The Combustion Air System can be acceptably maintained throughout the 54-month operating cycle by performance of the specified PMS actions. These include current actions and new actions recommended as a result of this analysis. No major maintenance is recommended for the Selected Restricted Availabilities (SRAs). Maintenance requirements for the follow-on ROH should be based on inspections conducted prior to that availability.

- Adequate material condition criteria and parameters have been established by the Navy and are in use for the Combustion Air System. They are defined by the 1200 PSI Propulsion Plant Test and Certification Manual tests and by current PMS requirements. For DDEOC, therefore, it is not necessary to develop performance and material condition criteria, performance tests, material inspections, and monitoring procedures for the Combustion Air System.

- In order to improve the material condition of the Combustion Air System, two ShipAlt proposals should be developed into FF-1052 Class ShipAlts. The first proposed ShipAlt would modify the Westinghouse Forced Draft Blower lubrication system. The second would install a valve-position indicating system to ensure that the motor-driven Lighting-Off Blower Isolation Valve is closed and locked before the Main Forced Draft Blowers are started.

- Several ShipAlts should be installed during Baseline Overhaul to improve the reliability of the Forced Draft Blowers:

  •• FF-1052-113D, Westinghouse Forced Draft Blower Lube Oil Pump Modification

  •• FF-1052-201K, Westinghouse FDB Steam Admission Valve Modifications

  •• FF-1052-409D, Hardie-Tynes FDB Steam Admission Valve Modifications

- Some PMS requirements for the Combustion Air System should be modified:

  •• Deletions - The "Propeller Blade-to-Casing Clearance Check" should be deleted from the Westinghouse MIP.

  •• Additions

  - The "Blower Shutter Leakage Test" should be added to the Hardie-Tynes MIP.
  - The "Blower Shutter Lubrication" requirement should be added to the Westinghouse MIP.

- Changes - Eight Forced Draft Blower actions should be changed from C (every 36 months) to 54M (every 54 months). These include actions such as cleaning and inspecting the casing and requesting outside assistance for the inspection of the turbine interior.
- New MRC Requirements - An MRC should be developed to clean and inspect the right-angle gear drive lube oil strainers.

These modifications will reduce the planned maintenance burden of the Hardie-Tynes Forced Draft Blowers by approximately 54 man-hours per ship and the Westinghouse Forced Draft Blowers by about 166 man-hours per ship during a 54-month cycle.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

In support of the DDEOC Program, which is sponsored by NAVSEA 934X, System Maintenance Analyses (SMAs) are being conducted on selected systems and subsystems of program-designated surface combatants. The principal element of an SMA is the Review of Experience (ROE). This report documents the ROE for the FF-1052 Class Combustion Air System, which was specifically selected for analysis since equipments of this system are on the FF-1052 Class Critical Equipment List.

1.2 PURPOSE AND SCOPE

An ROE is an analysis of existing and anticipated problems that affect the operational performance or maintenance program of a ship system. The ROE report serves as a vehicle for assessment of the significance and consequence of identified problems. Additionally, the report recommends specific actions which will prevent or reduce the impact of problem occurrence while improving material condition and maintaining or increasing system availability throughout an extended ship operating cycle.

The analysis documented herein is specifically applicable to the Combustion Air System of the FF-1052 Class and considered only system components which were installed aboard ship as of the fourth quarter of fiscal year 1976. The analysis utilized all available documented data sources from which system maintenance problems could be identified and studied. These included Maintenance Data Collection Subsystem (MDCS) data, and Casualty Reports (CASREPTs), in addition to Planned Maintenance Subsystem requirements data, system alteration documentation, and system technical manuals. Undocumented data sources utilized in this analysis included the results of discussions with Ship's Force and other cognizant technical personnel.

1.3 SYSTEM FUNCTION AND BOUNDARIES

The Combustion Air System consists of four steam-turbine-driven Forced Draft Blowers, two motor-driven Lighting-Off Blowers, support equipments,

and associated ducting. The Lighting-Off Blowers provide combustion air to the burners during initial light-off of the boilers until sufficient steam pressure is raised to operate the steam-turbine-driven Forced Draft Blowers. The steam-turbine-driven Forced Draft Blowers then assume the function of providing combustion air to the boilers during normal steaming operations from auxiliary steaming through full-power operation.

A comprehensive definition of system boundaries and a listing of system components included in the analysis documented by this report are presented in Appendix A.

1.4 REPORT FORMAT

The body of this report describes the analysis approach utilized (Chapter Two), briefly defines significant system maintenance problems encountered and discusses potential problem solutions (Chapter Three), and, finally, summarizes all the conclusions and recommendations derived from the analysis performed (Chapter Four). Specific analyses and evaluations that support the results of the effort reported herein are included in appendixes to this report. A selected list of references precedes the appendixes.

CHAPTER TWO

ANALYSIS APPROACH

This chapter details the techniques used to analyze the Combustion Air System. The analysis was initiated at the level at which APL numbers are assigned.

2.1 HULL GROUPS

The FF-1052 Class Combustion Air System was analyzed by ship group and equipment type as defined by shipbuilding contracts. Three groups of ships and equipments, differentiated by hull and by equipment manufacturer, resulted from these contracts. The three ship groups are identified in the following table:

Hulls	Text Reference	Number of Ships	Total Ship Years	Average Months per Ship
FF-1052 through FF-1097	Total Class	46	151.4	39.5
FF-1052 through FF-1077	Early Class	26	108.8	50.2
FF-1078 through FF-1097	Late Class	20	42.6	25.6

2.2 PROBLEM ANALYSIS

Maintenance Data Collection Subsystem (MDCS) and CASREPT narrative data from the FF-1052 Class for the period 1 January 1970 through 31 December 1974 were used in this analysis. All data reported under Combustion Air System Equipment Identification Codes (EICs) were reviewed, and all APLs specifically applicable to equipments of the Combustion Air System were identified.

Maintenance problems were identified primarily by analysis of the MDCS data. CASREPT data were used in an attempt to support the initial selection of problem APLs. The MDCS data were screened by computer (see Appendix B for the screening criteria) to identify the major contributors

to the Combustion Air System maintenance burden. Equipments judged to be minor contributors to the overall maintenance burden -- on the basis of a small number of ships reporting maintenance, low Ship's Force or IMA labor burdens, or low total replacement-part costs -- were eliminated from further analysis. Each remaining equipment was then analyzed to identify its high-usage repair parts and determine the replacement pattern for those parts. Low-usage repair parts were eliminated from further analysis as being insignificant contributors to the overall maintenance burden for a particular equipment. However, high-cost low-usage parts were analyzed in an attempt to define the major maintenance that was necessary on that equipment.

The foregoing steps identified the equipments in which maintenance problems occur and the repair parts that have been most frequently replaced in those equipments.

2.3 PMS EVALUATION

In addition to the analysis of specific problem parts, the current Planned Maintenance Subsystem (PMS) requirements were reviewed to determine if identified problem areas could be correlated with periodic routine maintenance and to determine if additional preventive maintenance could be incorporated into PMS to rectify those problems. The application (and inclusion in PMS) of performance or material condition assessment techniques was considered as a means for identifying the need for equipment and system maintenance.

2.4 NAVY CONTACTS

Discussions with Navy technical personnel helped to identify proposed ShipAlts for recently defined equipment problems, anticipated system technical improvements, and current areas of technical emphasis for the Combustion Air System. In addition, initial findings of the analysis conducted were discussed both with operator personnel, during ship surveys aboard operational FF-1052 Class ships, and with other cognizant technical personnel in an attempt to confirm these results and exchange potential problem solutions.

CHAPTER THREE

ANALYSIS RESULTS

This chapter presents the results of the analysis of the Combustion Air System.

3.1 APL SELECTION

Of the reported Combustion Air System APLs, only two met the final selection criteria. These APLs are applicable to the Westinghouse and Hardie-Tynes Forced Draft Blowers. Results of the CASREPT analysis (see Appendix C) and discussions with Navy technical personnel identified a problem with the motor-driven Lighting-Off Blower and motor that required analysis. In addition, the high part-replacement costs (as compared with those of other Combustion Air System equipments) reported against the Thermostatic Temperature Regulating Valve indicated that this equipment should also be analyzed. Thus four Combustion Air System equipments were analyzed. A summary of the maintenance-burden data reported against these equipments is presented in Table 3-1.

3.2 WESTINGHOUSE (EARLY CLASS) FORCED DRAFT BLOWERS (APL 057800178)

Westinghouse Forced Draft Blowers are installed in hulls FF-1052 through FF-1077 (the Early Class). Four Forced Draft Blowers are installed on each ship, for a total of 104 installations in the early class ships.

Analysis of MDCS data showed that considerable manpower and funds have been expended to maintain this equipment over the data period. The 26 applicable ships have reported a total of 1,077 maintenance actions. Repair parts cost a total of $95,224, for an average of about $875 per ship operating year. A total of 11,049 man-hours were reported against this system. Thus the average Ship's Force labor burden was about 80 man-hours per ship operating year, while the IMA labor burden averaged about 22 man-hours per ship operating year. This is about 102 man-hours per ship operating year for the Early Class, or about 25 man-hours per blower per ship operating year. There were 121 CASREPTs issued against these blowers or their related equipments during the data period. Fifteen of those reports were submitted against the motor-driven Lighting-Off Blowers.

Table 3-1. MDCS DATA SUMMARY OF COMBUSTION AIR SYSTEM APLs

APL	Nomenclature	Applicable Ships	Equipments per Ship	Total Equipment Population	Total Ship Operating Time (Ship-Years)	Ships Reported	JCNs	Ship's Force Man-Hours	IMA Man-Hours	Total Man-Hours	Parts Cost (Dollars)	Average Man-Hours/ Equipment/ Operating Year*
057800178	Westinghouse Forced Draft Blower	26	4	104	108.8	26	1077	8,664.3	2,384.4	11,048.7	95,224	25.4
057960029	Hardie-Tynes Forced Draft Blower	20	4	80	42.6	18	199	1,096.6	622.4	1,719.0	5,793	10.1
400090258	Motor-Driven Lighting-Off Blower	46	2	92 Units	151.4	18	27	175.1	114.3	289.4	1,853	3.4
174751884	Lighting-Off Blower Motor	46	2		151.4	15	29	253.7	428.1	731.8	413	
882141722	Thermostatic Temperature Regulating Valve	46	4	184	151.4	21	54	148.3	126.1	274.4	4,379	0.4
						Totals	1386	10,338	3,725.3	14,063.3	107,632	39.3

*Calculated as follows: $\dfrac{\text{(Total Man-Hours)} \div \text{(Total Number of That Equipment)} \times \text{(Number of Ships Having the Equipment)}}{\text{(Ship-Operating Years for Ship Group)}}$

Analysis of parts usage data identified parts experiencing high utilization. The parts identified by applying the screening criteria are listed in Table 3-2. CASREPTs identified the Steam Admission Valve and Attached Lube Oil Pump and Drive as Westinghouse Forced Draft Blower problem areas. A summary of the CASREPT analysis is presented in Appendix C.

Table 3-2. PART USAGE DATA-WESTINGHOUSE FORCED DRAFT BLOWER

Part Identification		Cost per Unit (Dollars)	Quantity per Equipment	Replacement Data			
NIIN	Nomenclature			Total Part Population	Number Replaced	Percent of Population Replaced	Number of Ships Reported
063-1178	Lube Oil Pump Pinion Gear	950	1	104	7	7	5
063-1179	Lube Oil Pump Gear	150	1	104	24	23	14
063-1180	Lube Oil Pump Gear	500	1	104	7	6	3
159-0750	Lube Oil Pump Gear and Pinion Matched Set*	1010	1	104	6	6	3
554-5396	Lube Oil Pump Bearing	1	2	208	42	20	11
063-1348	Steam Admission Valve Stem	300	1	104	34	33	9
059-6737	Journal Bearing	410	2	208	31	15	13
063-1176	Labyrinth Packing	110	1	104	67	64	16
063-1177	Labyrinth Packing	90	2	208	66	32	16

*Includes first three parts listed.

The following sections present the results of the analyses of the parts listed in Table 3-2.

3.2.1 Drive Gears for Attached Lube Oil Pump

A matched set of right-angle gears drives both the Attached Lube Oil Pump and the Woodward Governor. There is one set of gears for each blower. Parts usage data show that the individual gears have been replaced many times and the matched gear set has been replaced six times. The current APL for the Westinghouse Forced Draft Blower lists only the matched gear set (NIIN 159-0750). Ordinarily, individual gears are not replaced in the maintenance of matched gear sets. If one gear needs replacement, the entire matched set is usually replaced. However, the parts usage data reflect replacement of individual gears of the set. This can be explained by the fact that earlier versions of the Forced Draft Blower APL listed these gears individually rather than as a matched set. The gear replacements are shown in Table 3-2.

The number of replacements as a percentage of total population over the data period does not in itself suggest a problem with these gears. However, the replacement part cost totaled approximately $19,800, or about 21 percent of the total repair-parts costs reported against the entire

Early Class Forced Draft Blower. In addition, the Lube Oil Pump bearing (NIIN 554-5396) is a component of the right-angle gear drive, and the 42 replacements of this bearing closely coincide with the 44 total gear replacements. This bearing supports the input gear and pinion. A review of MDCS data for individual maintenance action showed that 40 percent of the time gears or bearings were replaced, gear and bearing replacements were coincident. It is thus reasoned that reducing the number of gear replacements will probably reduce the number of bearing replacements.

CASREPT analysis indicated that 14 (12 percent) of the 121 reports submitted were attributed to failure or excessive wear of the right-angle gear drive. Three of the reports identified clogged lube oil spray nozzles as the cause of excessive gear wear. Discussions with PMS 301 (1200 PSI Propulsion Plant Improvement Program) and the Naval Ship Engineering Center (NAVSEC) confirmed that the right-angle gear drive had experienced numerous failures and that the problem had been traced to a lube oil system problem. The lube oil filters provided with the Westinghouse Forced Draft Blowers were clogging up from system dirt and debris. When this occurred, the pressure built up and lifted the relief valve. As a result, contaminated oil by-passed the filters and flowed through the lubrication system. The lube oil sprayer nozzles that lubricate the right-angle gear drive became partially or completely blocked, reducing or restricting oil flow to the gear drive and shaft bearings. ShipAlt FF-1052-113D (see Appendix D for a listing of Combustion Air System ShipAlts), provided in kit form by Westinghouse, contains replacement sprayer nozzles and in-line strainers. The strainers are installed upstream of the nozzles and remove contaminants from the lube oil. Implementation of this ShipAlt should help alleviate lubrication system problems resulting from contaminated oil.

Contaminated-oil problems should also be reduced by the installation of a ShipAlt* that has been proposed by NAVSEC for Westinghouse Forced Draft Blowers. The ShipAlt consists of four elements:

1. A Parmatic Corporation oil filter would be installed in place of the existing Air Maze Filter.
2. A differential pressure gage would be installed across the filter to determine when the filter needs replacement.
3. The existing Lawler thermostatic control valve would be replaced by an Amot thermostatic control valve to improve temperature control of the lube oil.
4. The Auxiliary Lube Oil Pump motor controller would be modified to provide automatic start-up of the pump when the bearing oil pressure drops below 8 psig.

The installation of this proposed ShipAlt and ShipAlt FF-1052-113D should eliminate bearing and gear drive problems caused by contaminated oil, improve oil temperature control, and ensure sufficient oil flow to the bearings at low fan speeds.

*Reference 15.

3.2.2 Steam Admission Valve

The Steam Admission Valve meters the flow of steam into the steam chest of the Forced Draft Blower. One valve is installed in each blower, for a total of four valves per ship.

The Steam Admission Valve represents a major problem associated with the Westinghouse Forced Draft Blower, its component parts having been replaced a total of 34 times, representing 33 percent of the part population.

CASREPT analysis identified several problems with this valve that were substantiated by ship surveys. Analysis of CASREPT data showed that 37 (31 percent) of the 121 CASREPTs reviewed concerned the Steam Admission Valve. The principal failure modes reported were leaks between the valve cage and the steam chest body, leaks between the plug and the seat, leaks around the steam guide bushings, and broken or worn piston rings. The most frequently reported symptom is the inability to set minimum blower rpm. Steam cuts between the cage and the steam chest, as well as leakage past the valve, permit steam to enter the turbine when the valve is closed, resulting in uncontrolled blower rotation.

ShipAlt FF-1052-201K has been developed to solve these problems. The work specified by this ShipAlt involves removing the double-seated valve stem, the seat and cage assembly, and the two-piece stem guide bushings from the existing Steam Admission Valve. The valve body will be refitted with a single-seat, heavy-duty stem and plug. The valve will be seal-welded to the valve body and a single, heavy-duty stem guide bushing and stem seal rings will be installed on the valve stem. Implementation of this ShipAlt should eliminate most of the Steam Admission Valve problems in the Westinghouse blower.

3.2.3 Kingsbury Journal Bearing

The Kingsbury Journal Bearing was identified as a significant contributor to the parts utilization reported against the Combustion Air System. CASREPT data showed that only 9 (7 percent) of 121 reports were submitted against the bearing. It is likely that the bearing failures have been the result of lube oil contamination.

Solutions to the lube oil problems are established (see Section 3.2.1) and should reduce the number of Journal Bearing replacements. ShipAlt FF-1052-113D will indirectly benefit the bearings because of the new in-line lube oil strainers installed in the spray nozzle piping. In addition, the ShipAlt* in preparation by NAVSEC will provide new oil filters in the lube oil system. Installation of these ShipAlts will reduce or eliminate equipment problems caused by contaminated oil.

**Ibid.*

3.2.4 Labyrinth Gland Packing Assemblies

Although the Labyrinth Gland packing assemblies (NIINs 063-1176 and 063-1177) appeared to have a high utilization rate, they are not a significant problem. Although improper installation can cause failure, the usual reason for replacing these parts is leakage caused by increased clearance from wear. This was substantiated by discussion with NAVSEC (PHILADIV) personnel. Review of CASREPTs revealed only two reports concerning Labyrinth Gland packing failures; one of these was associated with a suspected bearing failure. Ship surveys did not reveal any additional problems with Labyrinth Gland packing assemblies. The ship survey of FF-1063 did identify a case of repeated replacements due to constant leakage; however, the leakage was traced to pitted shaft glands, which Ship's Force thought were caused by a massive system "salt up" incident in 1972.

Spare packing assemblies are carried on board and their replacement is within the capability of the Ship's Force. It should be noted that permanent repair of shaft gland problems such as pitting or scoring requires industrial assistance.

3.2.5 Westinghouse Forced Draft Blower BOH Requirements

The problems discussed in the previous sections have been identified as the only significant recurring problems experienced by the Westinghouse Forced Draft Blower. As stated earlier, there are several Navy-developed corrective measures that should be implemented to improve the material condition of the Westinghouse Forced Draft Blower and its ancillary equipments and to increase the likelihood that those equipments will operate reliably throughout the extended cycle. With the accomplishment of these actions prior to or during BOH, the major Westinghouse Forced Draft Blower problems should be corrected. Therefore, Class B overhaul of all four Forced Draft Blowers should not be mandatory during BOH. However, because it is anticipated that some blowers will require repair before entering the extended operating cycle, Class C repairs of individual blowers should be accomplished during BOH.

3.3 HARDIE-TYNES (LATE CLASS) FORCED DRAFT BLOWER (APL 057960029)

Hardie-Tynes Forced Draft Blowers are installed on Hulls FF-1078 through FF-1097, four on each ship, for a total of 80 installations on these 20 ships. These ships operated for a total of 42.6 ship operating years, or an average of 25.6 months per ship.

The analysis of the Hardie-Tynes blowers showed that they represent a relatively low overhaul maintenance burden and do not have significant part replacement rates. The total replacement-parts cost was $5793, an average of $136 per ship operating year. The maintenance man-hour burden was also small, as shown in Table 3-1. There were 22 CASREPTs reported against the Late Class Combustion Air System. Sixteen of these reports

were submitted against the Hardie-Tynes Forced Draft Blower and its ancillary equipment. These did not identify any commonly recurring causes. The other six reports were submitted against the motor-driven Lighting-Off Blower.

Ship surveys of Hardie-Tynes blower ships did not disclose any significant problems with these blowers. However, discussions with NAVSEC personnel indicated that the Steam Admission Valve does not seat properly when closed, thus permitting steam leakage through the valve to drive the blower slowly. NAVSEC has prepared ShipAlt FF-1052-409D to replace the Steam Admission Valve (APL 883000359), a single-seat, mechanically operated globe valve manufactured by the Mason Neilan International Company. It allows steam to enter the steam chest in response to a mechanical signal generated by the Woodward Governor. Each blower is equipped with one valve. The ShipAlt is designed to preclude leakage through the valve seat and the Flexitallic sealing gasket. Installation of the ShipAlt will eliminate steam flow into the steam chest when the valve is completely closed. The ShipAlt requires removing the Flexitallic gasket and welding the valve seat to the body. ShipAlt FF-1052-409D should be installed during Baseline Overhaul to ensure acceptable performance during the 54-month extended operating cycle.

The Steam Admission Valve problem discussed above is the only significant recurring problem experienced by the Hardie-Tynes Forced Draft Blower. As stated, ShipAlt FF-1052-409D should be implemented to improve the material condition of the valve and blower and to increase the likelihood that the blower will operate reliably throughout the extended cycle. With the accomplishment of this ShipAlt prior to or during BOH, the valve problem should be corrected. There is no indicated need for mandatory Class B overhaul of the Hardie-Tynes Forced Draft Blowers during BOH. Because it is anticipated, however, that some blowers will require repair before entering the extended operating cycle, Class C repairs of individual blowers should be accomplished during BOH.

3.4 MOTOR-DRIVEN LIGHTING-OFF BLOWER AND MOTOR (APLs 400090258 AND 0174751884)

Each FF-1052 Class ship has two motor-driven Lighting-Off Blowers to supply air to the boilers during light-off. These blowers are operated until the boilers generate sufficient steam to drive the turbine-driven Forced Draft Blowers.

Analysis of MDCS data did not identify any high-usage parts for these blowers. However, the blower and motor consumed about 1021 man-hours for corrective maintenance and $2266 in part replacement costs during the data period. CASREPT analysis and ship surveys revealed a problem that is caused by operator errors during system operation. The motor-driven Lighting-Off Blowers operate during boiler light-off until the steam drum pressure has exceeded 900 psig and the Forced Draft Blowers are lighted off. The motor-driven Lighting-Off Blowers are then secured, and the

blower isolation valve is supposed to be closed and locked. The blower isolation valves isolate the motor-driven blower discharge from the Forced Draft Blower ducting and are closed and locked manually by fireroom personnel. However, in many instances, failure to close and lock the valves has caused severe problems with the motor-driven Lighting-Off Blower fan and motor. If the Forced Draft Blower is started without closing and locking the valve, the high air-flow rate causes the motor-driven Lighting-Off Blower fan to windmill backwards. As the Forced Draft Blower reaches operating speed, the motor-driven Lighting-Off Blower fan windmills until it disintegrates. Often this results in complete destruction of the fan and the blower motor. CASREPT analysis shows that 11 (8 percent) of 143 Combustion Air System reports were attributed to windmilling and overspeeding of the motor-driven Lighting-Off Blower caused by failure to close and lock blower isolation valves.

Failure of a Lighting-Off Blower is significant because its associated boiler cannot be started until steam from the other boiler is available to operate the Forced Draft Blowers. Failure of both Lighting-Off Blowers would generally prohibit lighting off either of an FF-1052 Class ship's two boilers. However, in an emergency the boilers could be lighted off by pressurizing the fireroom (assuming that electrical power is available to drive ventilating fans).

A ShipAlt* has been proposed by NAVSEC that should reduce the occurrence of operator error. The ShipAlt will modify the blower installation so that the position of the isolation valves can be readily determined at any time. Such determination will be made possible by installing a limit switch on the valve and an indicator system at the operating station to denote the position of the shutters. Hence, ship personnel will be able to verify easily that the valves are closed and locked before lighting off the Forced Draft Blowers.

3.5 THERMOSTATIC TEMPERATURE REGULATING VALVE (APL 882141722)

The Thermostatic Temperature Regulating Valve controls the flow of cooling water through the Forced Draft Blower Lube Oil Cooler to regulate the temperature of the lubricating oil. One valve is installed on each Forced Draft Blower, for a total population of 184 valves on 46 ships. The oil temperature is measured at the outlet of the oil cooler in the lube oil line, while the regulating valve is installed at the water-outlet side of the cooler. The valve is a Lawler SF type valve (called a "Thermostatic Temperature Regulator with a Self-Closing Safety Feature" by the manufacturer).

The MDCS data presented in Table 3-1 show that 274 man-hours were reported by 21 ships over 151.4 ship operating years (total class). This is approximately two man-hours per ship operating year. The MDCS parts usage data indicated numerous replacements of the thermostatic bulb

*Reference 16.

(NSN 9C-4820-00-9330734). Replacement occurred 30 times on 15 ships during the data period. The total replacement cost was $4380, or $29 per ship operating year. Two CASREPTs were reported against this valve -- both for an inoperative valve that made it impossible to control the lubricating oil temperature. Three opinions relative to this problem were expressed during ship surveys:

- The valve worked acceptably but did not maintain the lube oil at a sufficiently high temperature (it was believed that the specified temperature range -- 110° F to 130° F -- is too low).
- The valve could not be made to work, so that the oil temperature had to be regulated manually.
- The valve worked but required constant adjustment.

It was also reported that one thermostatic element was replaced but did not constitute a problem because the part was stocked on board and Ship's Force personnel could replace the element. NAVSEC has prepared a ShipAlt* to replace the Lawler valve with an Amot thermostatic control valve. A ShipAlt number had not been assigned to this proposal as of 2 November 1976. This ShipAlt should solve the temperature regulation problem.

3.6 EVALUATION OF PMS REQUIREMENTS

3.6.1 Introduction

The PMS requirements** for the Combustion Air System were evaluated for content -- that is, whether performing the specified maintenance actions would maintain acceptable material condition of the Forced Draft Blowers. They were also evaluated for agreement between the requirements for the two blower designs. In addition, all maintenance requirements with cyclic periodicity (every 36 months) were examined to determine if any material condition degradation would result if the periodicity were extended to 54M (every 54 months). Extending the periodicity would ensure that maintenance actions normally requiring outside assistance, or normally scheduled during ROH, would be accomplished during the ROH that occurs at the end of each extended operating cycle. Changes to PMS requirements are listed on the DDEOC MRC Evaluation form in Appendix E.

The maintenance requirements for the Combustion Air System were evaluated by comparing the noted problem areas and the listed PMS requirements to determine if the required actions would adequately maintain the material condition of system equipments throughout an extended operating cycle. If the requirements were inadequate, the PMS actions necessary to maintain a given equipment were determined. Recommendations were developed for modifying PMS to ensure adequate planned maintenance during the extended operating cycle.

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*Reference 15.

**References 12 and 13.

All of the maintenance requirements listed on MIP F-2/101-B5 (Westinghouse) were compared with those listed on MIP F-2/125-95 (Hardie-Tynes) to determine similarity in content. The discovery of differences initiated an investigation into the need and desirability of making the requirements comparable. Allowing for differences in blower design,the comparison determined that, although the specific MRCs for each MIP requirement were different, comparable if not virtually identical maintenance was required for the two blower designs. However, there were two differences between the maintenance requirements for the blowers -- the propeller blade and casing clearance check and the Forced Draft Blower shutter maintenance requirements.

The cyclic maintenance requirements on MIP F-2/101-B5 (Westinghouse) and MIP F-2/125-95 (Hardie-Tynes) were evaluated to determine if their periodicity could be extended to 54M (every 54 months) without degrading the material condition of the Forced Draft Blowers.

The rationale for performance of these efforts is to define the operating-cycle maintenance requirements for the Combustion Air System. These requirements are listed on the Maintenance Index Pages (Reference 12) and the DDEOC MRC Evaluation form included in Appendix E.

3.6.2 Right-Angle Gear Drive Lube Oil Strainer Requirement

ShipAlt FF-1052-113D has been installed on most of the Westinghouse Forced Draft Blowers of the FF-1052 Class. One major item in this ShipAlt is the installation of lube oil strainers in the lube oil supply lines to the right-angle rear drive sprayer nozzles. These strainers were installed to prevent the sprayer nozzles from clogging because of the accumulation of dirt in the lube oil system. If the strainers become plugged and limit oil flow to the nozzles, no oil will be supplied to the right-angle gear drive. Thus the gear failures that the ShipAlt was developed to eliminate might still occur. However, gear failures can be minimized or eliminated by cleaning the strainers at regular intervals. NAVSEC has suggested that the strainers be cleaned monthly until the Lube Oil System modifications are complete (see Section 3.2.1 for a description of the NAVSEC ShipAlt proposal). After the Lube Oil System is modified, the periodicity should be extended because the system will have greater filtration capability.

3.6.3 Propeller Blade Clearance Check

A semi-annual check (MRC B5-J28L-N) of the clearance between the propeller blades and the blower casing is required by the Westinghouse Blower MIP (MIP F-2/101-B5). The Hardie-Tynes Forced Draft Blower MIP (MIP F-2/125-95) does not list this MRC or a similar requirement. Such checks are not necessary and do not affect the reliability or material condition of either Forced Draft Blower. The manufacturers of the Forced Draft Blowers apparently agree, because the only mention of the propeller-to-casing clearance in either technical manual* occurs on sectional

*References 4 and 5.

drawings of the blowers. No requirement to check the clearances is listed in the planned-maintenance sections of the technical manuals. The clearance is not significantly affected by normal operation of the blower, so exceeding clearance specifications by a small amount would not degrade blower performance. The reduction in clearances is a function of catastrophic part failure and cannot be prevented by performing the clearance check.

Catastrophic failures of the Forced Draft Blowers have not been reported by FF-1052 Class ships. MDCS data show no replacements of propeller blades for either of these blowers. The CASREPT data show no occurrence of catastrophic failures associated with out-of-specification clearances. In addition, no CASREPTs have reported excessive downtime or man-hour expenditures as a result of clearance problems.

Eliminating the requirement to check the clearances will decrease the planned maintenance burden by 2 man-hours per blower per year, or 8 man-hours per ship per year. This represents a saving of 208 man-hours per year for the 26 ships with Westinghouse Forced Draft Blowers. The total planned maintenance burden saving over a 54-month operating cycle would be 1040 man-hours.

3.6.4 Forced Draft Blower Shutter Requirements

Another difference between blower requirements concerns the Forced Draft Blower shutters. Two different maintenance requirements are specified, one appearing on the Hardie-Tynes blower MIP and the other on the Westinghouse blower MIP. These requirements should be on both MIPs because blower performance and shutter reliability can be degraded by failure to perform the specified maintenance.

In the first case, MRC B5-J28M-N specifies an annual test of the shutter for leakage. This requirement is listed only on the Westinghouse blower MIP. Checking the shutters for leakage determines whether they need replacement and reduces the possibility that the blower will windmill backwards. In addition, a leaking shutter can cause bearing problems by allowing the Forced Draft Blower to turn too slowly to provide sufficient oil pressure to adequately lubricate the journal bearings. Therefore, checking the shutters for leakage and replacing or repairing them when indicated by the inspection will prevent specific journal bearing problems and reduce blower windmilling.

In the second case, MRC C1-A93L-Q specifies quarterly lubrication of the shutter counterweight mechanism. This action, listed only on the Hardie-Tynes blower MIP, would improve the reliability of the shutter and counterweight mechanism by ensuring that sufficient lubrication is available for the rotating parts.

The addition of the two requirements to the blower MIPs would increase the planned maintenance burden of each blower. The Westinghouse blower burden would be increased 0.3 man-hour per blower per quarter by adding

MRC C1-A93L-Q to MIP F-2/101-B5. This is 1.2 man-hours per ship per quarter, or 124.8 man-hours per year for the 26 ships on which Westinghouse blowers are installed. The addition of MRC B5-J28M-N to MIP F-2/125-95 would increase the Hardie-Tynes blower burden 1 man-hour per blower per year, or 80 man-hours per year for the 20 Hardie-Tynes blower-equipped ships.

3.6.5 Cyclic Maintenance Evaluation

There are five cyclic maintenance requirements on the Westinghouse MIP and six on the Hardie-Tynes MIP. The five Westinghouse requirements and the six Hardie-Tynes requirements are equivalent actions. The MIPs and MRCs applicable to each Forced Draft Blower are listed in Table 3-3.

Table 3-3. CYCLIC MAINTENANCE REQUIREMENTS FOR FORCED DRAFT BLOWERS

MRC Number	MIP Number	Forced Draft Blower
25-F93W-N	F-2/101-B5 and F-2/125-95	Westinghouse and Hardie-Tynes
B5-J28N-N	F-2/101-B5	Westinghouse
B5-J28P-N	F-2/101-B5	Westinghouse
45-G71Z-N	F-2/125-95	Hardie-Tynes
95-H85G-N	F-2/125-95	Hardie-Tynes
32-B26V-C	F-2/125-95	Hardie-Tynes
35-G33C-N	F-2/101-B5 and F-2/125-95	Westinghouse and Hardie-Tynes
MIP Entry C-11	F-2/101-B5 and F-2/125-95	Westinghouse and Hardie-Tynes

These maintenance requirements specify the following actions for Forced Draft Blowers:

1. Clean, inspect, and preserve exterior of turbine casing.
2. Inspect shaft journals, bearings, seal rings, and Labyrinth Gland packing; measure clearances.

3. Deliver lube oil cooler to repair facility for cleaning and testing.

4. Clean and inspect turbine steam strainer.

5. Request repair activity to:

   a. Inspect interior of turbine casing for steam erosion and deterioration.

   b. Inspect turbine wheel and nozzle blocks for cracks and other damage; measure nozzle throat diameter for erosion.

A review of MDCS data indicated that the corrective maintenance that would normally result from the cyclic inspections has not occurred. For example, Westinghouse blower journal bearing replacements on ten Early Class ships that had operated for 48 months without overhaul totaled 16, or 20 percent of the bearing population. These data compare with the 31 reported replacements (15 percent) for the 26 Early Class ships, showing only a slight increase in usage for the older ships. Because of this low percentage of bearing replacements for the Early Class ships, it is concluded that the PMS inspections did not establish the need for that corrective maintenance.

The CASREPT data show that 13 (9 percent) of 143 of the Combustion Air System CASREPTs were submitted for discrepancies that might be associated with the above-listed blower inspections. Ships submit CASREPTs to inform operational and logistics commands that a ship and particular system are operating at reduced capability. If parts or facilities are needed to correct equipment problems, and thus return capability to normal, this information is generally specified in the CASREPT. Priority can be given for purchasing specific parts as part of the overall process of returning the system and ship to operational status. CASREPT data are also used by the TYCOM in an informal fashion to indicate repetitive problems with systems and subsystems. A large number of CASREPT submittals for a particular system can support a decision to perform major maintenance or overhaul during RAVs and ROHs. However, small numbers of such submittals indicated that there were no repetitive problems occurring within the Combustion Air System that would indicate the need for major maintenance or overhaul. Nine CASREPTs (6 percent) were submitted for bearing problems, two (1 percent) for nozzle problems, and two (1 percent) for Labyrinth Gland problems. Because of the small numbers of possible PMS-related CASREPTs, it is concluded that there are no continuing problems attributable to PMS-required maintenance. Therefore, it is unlikely that future problems will occur because of the specified maintenance or that extension of the periodicities will degrade the material condition of the Combustion Air System during the 54-month operating cycle.

Discusssions with ship personnel substantiated the conclusion that the Forced Draft Blowers have not experienced any significant major maintenance of the type that would be associated with the cyclic PMS inspections and actions. Ship personnel were of the opinion that the overhaul cycle for Forced Draft Blowers could be extended from the current nominal 36 months to five or six years.

3.6.6 PMS Burden Changes

Changes to the PMS requirements alter the planned maintenance burden for both the Westinghouse and Hardie-Tynes Forced Draft Blowers. The burden changes and resulting savings are functions of the deletion of requirements, the addition of requirements, and the change in periodicity of requirements. The complete calculations for each type of blower are contained in Appendix F; the results are summarized here.

The changes in the Westinghouse Forced Draft Blower PMS requirements result in maintenance-burden savings of about 4305 man-hours for all Westinghouse blowers (166 man-hours per ship) over a 54-month operating cycle. The changes in the Hardie-Tynes Forced Draft Blower PMS requirements result in maintenance burden savings of about 1080 man-hours for all the Hardie-Tynes Forced Draft Blowers (about 54 man-hours per ship) over a 54-month operating cycle.

3.7 MATERIAL CONDITION ASSESSMENT

Methods for assessing the material condition of the Combustion Air System have been established. Two methods are specified in tests from the 1200 PSI Propulsion Plant Test and Certification Manual. First, the Boiler Flexibility Test* assesses the ability of the entire Propulsion System to make a 70-percent change in boiler load within 45 seconds. Second, the Combustion Air System Test** assesses the condition of the Combustion Air System and measures its performance against specified criteria. Third, the PMS maintenance requirements specify testing and condition assessment procedures for individual Combustion Air System equipments.

The 1200 PSI Propulsion Plant tests were developed to improve the operational reliability and readiness of the Propulsion Plant. The tests discussed here are utilized during the Pre-Overhaul Test and Inspection (POT&I) to "identify repairs and corrective actions required for safe and reliable operation of the propulsion plant".† These tests are also used after ship/system overhaul to "demonstrate that the propulsion plant fulfills all requirements specified for developing power to propel and service the ship, and that all associated machinery and equipment perform to the capability of the approved design."†

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*Reference 18.
**Reference 19.
†Reference 20.

The Boiler Flexibility Test assesses the response of the Boilers, the Feed System, the Condensate System, the Combustion Air System, and the Automatic Combustion and Feedwater Control System to rapid changes in boiler load. The test procedure specifies an increase in boiler load from about 20 percent of full power to about 90 percent of full power within 45 seconds. The upper and lower limits are not necessarily limited to 20 percent and 90 percent of full power, but must not be less than 15 percent or greater than 95 percent. The differences between the upper and lower limits must not be less than 70 percent of full power. The Propulsion System must also be able to respond to a decrease in boiler load from about 90 percent of full power to about 20 percent of full power within 45 seconds. Again, the difference between the upper and lower limits must not be less than 70 percent of full power. The ability of the Propulsion System to meet the requirements of the test indicates that the system has acceptable material condition and performance. Inability of the Propulsion System to meet the requirements of the test indicates that some maintenance is necessary to bring the performance of individual systems up to acceptable standards. Individual tests are available to assist in diagnosing specific equipment problems for different Propulsion System subsystems.

The Combustion Air System test specifies testing procedures, condition standards, and performance requirements for individual system equipments. It comprises equipment inspections and performance tests. The inspections assess the condition of the system's equipments -- that is, whether the equipments are in acceptable operating condition, whether all fasteners are tight, whether sufficient lubrication is available to operate the equipment, etc. Motor-winding insulation measurements are taken, as well as readings of supply voltage, to determine if motor-driven equipments can operate at the designed speeds during testing. The performance tests determine if the tested equipment meets minimum standards of acceptable performance. For example, relief valves, pressure switches, and temperature control valves are tested to verify that they are set correctly. Once these individual equipments have been tested and determined to be in satisfactory operating condition, the Main Forced Draft Blower is tested to determine that it can supply the boilers with the proper amount of combustion air.

PMS requirements for the Combustion Air System specify tests and inspections of individual equipments on a calendar-time basis. Included in these requirements are tests of the speed-limiting governor, the tachometer, the lube oil low pressure trip, the combined exhaust and relief valve, and the blower shutters. Testing the performance of the Forced Draft Blower is not required by the current Maintenance Index Pages (MIPs). However, while not a part of PMS, the 1200 PSI Propulsion Plant Test and Certification Manual Combustion Air System Test are adequate for testing the performance of the blower.

Thus material condition assessment procedures for the Combustion Air System are well defined and are available at three levels: the Propulsion System level, the Combustion Air System level, and the individual equipment

level. These tests and inspections are entirely adequate to determine the material condition and performance capabilities of the Combustion Air System and its individual equipments. Therefore, there is no need for any additional performance and material condition criteria, performance tests, material inspections, or monitoring procedures for the Combustion Air System.

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the conclusions and recommendations resulting from the analysis of the Combustion Air System.

4.1 CONCLUSIONS

The principal conclusion of the Review of Experience documented by this report is that the Combustion Air System can operate reliably throughout a 54-month extended operating cycle without overhaul, and with a decrease in the planned maintenance labor burden. This can be accomplished by performance of the specified PMS planned actions. No major maintenance is recommended for the Selected Restricted Availabilities (SRAs). Class B overhaul of the Forced Draft Blower will not be required during Baseline Overhaul, even though Class C repairs will be necessary on individual blowers. Maintenance requirements for the follow-on ROH should be based on inspections conducted prior to that availability.

A second conclusion of the analysis is that performance and material condition criteria, performance tests, material inspections, and monitoring procedures need not be developed for the Combustion Air System, because well defined material condition assessment procedures and parameters are available and in use. The 1200 PSI Propulsion Plant Test and Certification Manual lists one test for the Propulsion System and one test for the Combustion Air System that address both the material condition and the performance capabilities of the Combustion Air System. Individual equipments are addressed by the current PMS for the Combustion Air System.

4.2 ACTION RECOMMENDATIONS

This section presents the specific recommendations resulting from the Review of Experience of the Combustion Air System. These recommendations should be implemented to provide adequate support of the Combustion Air System during the 54-month extended operating cycle. The recommendations are listed within the following categories: Reliability and Maintainability Improvements (4.2.1); PMS Changes (4.2.2); and Baseline Overhaul (BOH) Requirements (4.2.3). Action items resulting from these recommendations are listed in the DDEOC Action Table included in Appendix G.

4.2.1 R&M Improvements

4.2.1.1 FDB Lube Oil System ShipAlt Proposal

Recommendation

Develop a ShipAlt proposed by NAVSEC to modify the Lube Oil System of Westinghouse Forced Draft Blowers (letter to NAVSEA 934 and PMS-301; 6153B5/HBB; 9251/FF1052C1; Ser 1251; dated 28 July 1976; Subj: Forced Draft Blower Oil System Modifications).

Problem

Contaminated oil in the Forced Draft Blower Lube Oil System is causing reliability problems in the Westinghouse Forced Draft Blower.

Explanation

Various data sources indicated that contaminated oil in the Lube Oil System of the Westinghouse Forced Draft Blower has caused problems with the Attached Lube Oil Pump right-angle gear drive. CASREPT analysis indicated that 14 of 143 (10 percent) Combustion Air System reports were attributed to failure or excessive wear of the right-angle gear drive. MDCS data indicated that about 21 percent of the total replacement-part dollars reported against the Combustion Air System were attributable to the right-angle gear drive. The total replacement-part costs were about $19,800. Discussions with NAVSEC personnel indicated that the Westinghouse lube oil filters became clogged with dirt. As a result, the lube oil pressure increased and lifted the relief valve. Lube oil flow then bypassed the lube oil filters, allowing contaminants to continue through the Lube Oil System and into the right-angle gear drive spray nozzles. The nozzles then became clogged and did not lubricate the gears.

The ShipAlt proposal from NAVSEC will reduce the oil contamination problems by installing a different oil filter in the Lube Oil System. In addition, a differential pressure gage will be installed across the inlet and outlet of the filter so that ship personnel can determine when the lube oil filter is clogged. Temperature control of the lube oil will be improved by replacing the current thermostatic control valve with an Amot valve. Finally, the motor-driven Auxiliary Lube Oil Pump motor controller will be modified to provide automatic start-up of this pump when the lube oil pressure drops below 8 psig. Development and installation of this ShipAlt proposal will reduce contaminated oil problems, improve lube oil temperature control, and ensure sufficient oil to the bearings during operation at low fan speed.

4.2.1.2 Motor-Driven Lighting-Off Blower

Recommendation

Develop the ShipAlt proposed by NAVSEC to install a system to indicate the position of the isolation valve.

Problem

Numerous failures of the motor-driven Lighting-Off Blowers have been attributed to operation of the Main Forced Draft Blowers with the blower isolation valve open.

Explanation

Operation of the Main Forced Draft Blowers with the isolation valves of the motor-driven Lighting-Off Blowers open permits the Main Forced Draft Blower discharge to be applied to the Lighting-Off Blower fan. When this occurs, the Lighting-Off Blower fan windmills backwards and exceeds rated speed. Damage to the unit usually occurs in the form of catastrophic failure of the fan blades, overheating of the motor (necessitating motor rewind), or deformed blower ducting. Operator error or carelessness is the primary cause of the problem. CASREPT data show that 11 of 143 CASREPTs were submitted for failures directly attributable to personnel neglecting to close and lock the isolation valves. Even though closing and locking the isolation valve is a required step when lighting off the boilers, there is no indication at the operating station that the operation has been completed.

Failure of a Lighting-Off Blower is significant because its associated boiler cannot be lighted off until steam from the other boiler is available to operate the Main Forced Draft Blowers. Failure of both Lighting-Off Blowers would generally prohibit lighting off either of a FF-1052 Class ship's two boilers. However, in an emergency the boilers could be lighted off by pressurizing the fireroom (assuming that electrical power is available to drive ventilating fans).

The ShipAlt proposed by NAVSEC would install a limit switch on the isolation valve and an indicating system in the operating station. The position of the isolation valve could be verified during boiler light off. It is expected that Lighting-Off Blower failures will be reduced when this proposal is developed into a ShipAlt and the equipment is installed on FF-1052 Class ships.

4.2.1.3 Lube Oil Pump Drive Gears (Westinghouse Design)

Recommendation

Install ShipAlt FF-1052-113D during BOH.

Problem

Numerous failures of the Attached Lube Oil Pump drive gear assembly of the Westinghouse Forced Draft Blowers have occurred as a result of inadequate lubrication.

Explanation

The principal cause of the drive gear assembly failures has been traced to lack of adequate lubrication. The lube oil sprayer nozzles that supply oil to the drive gears are clogging up with dirt that is entrapped within the system. The contamination enters the sprayer nozzles and the system because the oil filters frequently clog. The clogged filters increase the oil pressure and, as a result, the lube oil filter relief valve actuates. Lube oil bypasses the filter elements and flows through the entire Lube Oil System.

ShipAlt FF-1052-113D provides for replacement of the existing drive gear spray nozzles with new spray nozzle units. In-line strainers will be installed in each of the two gear spray nozzle lube oil supply lines. The ShipAlt modifies the oil filter system by replacing the relief valve spring and installing a differential gage across the lube oil filter inlet and outlet piping. The pressure gage will aid identification of a clogged condition within the filter element.

Implementation of this alteration should not only alleviate the problems with the gear drive assembly but should minimize bearing and labyrinth packing failures by improving lube oil quality.

4.2.1.4 Steam Admission Valve (Westinghouse Design)

Recommendation

Install ShipAlt FF-1052-201K during BOH.

Problem

Ship surveys and CASREPT information indicate that the Steam Admission Valve is the major maintenance problem associated with the Westinghouse Forced Draft Blower. Corrective actions require excessive expenditure of both Ship's Force and IMA man-hours.

Explanation

Review of CASREPT data shows that 37 (31 percent) of 121 reports were related to malfunctions of the Steam Admission Valve. The Steam Admission Valve is the major source of Forced Draft Blower CASREPTs. Principal failure modes include leakage between the valve cage and the steam chest body, steam cuts on the valve seat, steam leakage past the two valve stem bushings, and broken or worn piston rings. Binding of the stem and the inability to set blower minimum speed are the principal symptoms of failure.

ShipAlt FF-1052-201K provides for extensive modifications of the valve. Valve modifications consist of the removal of the existing double-seated valve stem, the seat and cage assembly, and the two-piece stem guide bushings. The valve body is modified and refitted with a single seat, heavy-duty valve stem and plug. The valve seat is then seal-welded to the valve body, and a single heavy-duty guide bushing and heavy-duty steam seal rings are installed on the valve stem.

Accomplishment of this alteration will minimize Steam Admission Valve problems caused by steam leaks.

4.2.2 PMS Changes

4.2.2.1 Check of Propeller Blade to Casing Clearance

Recommendation

Delete MRC B5-J28L-N from MIP F-2/101-B5 (Westinghouse Forced Draft Blower). This MRC requires a semi-annual check of the clearance between the fan blade tips and the casing.

Problem

These clearance checks are not diagnostic.

Explanation

The MDCS show no part replacements that could be associated with deviations from the required clearance specification. No CASREPTs have been reported that indicated blower failures as a result of out-of-specification clearances. In addition, ship surveys and discussions with Navy technical personnel indicated that no problems exist with respect to fan blade to casing clearances. It is acknowledged that excessive deviation from specification could cause major damage to the Forced Draft Blower, incurring significant equipment downtime as a result. However, the lack of CASREPTs concerning clearance-related failures indicates that those failures have not occurred, especially on a class-wide basis. Significant clearance deviations are caused by failure of components of the Forced Draft Blower and result in catastrophic failure of the blower. These failures are not prevented by measuring fan blade to casing clearance.

Deletion of this requirement from the Westinghouse blower MIP will save about 8 man-hours per ship per year, or about 1040 man-hours for the 26 ships that have Westinghouse blowers over the 54-month operating cycle.

4.2.2.2 Leakage of Forced Draft Blower Shutters

Recommendation

Add MRC B5-J28M-N (Test Blower Shutters for Leakage) to the Hardie-Tynes MIP (F-2/125-95).

Problem

An applicable maintenance requirement is not listed on the Hardie-Tynes Forced Draft Blower MIP.

Explanation

MRC B5-J28M-N is an annual requirement to test the Forced Draft Blower shutters for leakage. This requirement is currently listed on the Westinghouse Forced Draft Blower MIP but not on the Hardie-Tynes Forced Draft Blower MIP.

The leakage check is listed on the Westinghouse Blower MIP as a preventive measure. Performing the action ensures that the blower will not windmill backwards because of leaking shutters.

A leaking shutter can cause bearing problems by allowing the Forced Draft Blower to turn too slowly to provide sufficient oil pressure to lubricate the journal bearings adequately. Therefore, checking the shutters for leakage and replacing or repairing them when indicated by the inspection will prevent specific journal bearing problems and reduce blower windmilling.

4.2.2.3 Lubrication of Forced Draft Blower Shutter

Recommendation

Add MRC Cl-A93L-Q (Lubricate Shutters and Counterweight Mechanism) to the Westinghouse Forced Draft Blower MIP (F-2/101-B5).

Problem

An applicable system maintenance requirement is not listed on the Westinghouse Forced Draft Blower MIP.

Explanation

MRC Cl-A93L-Q is a quarterly requirement to lubricate the blower shutters and counterweight operating mechanism. This requirement is currently listed on the Hardie-Tynes Forced Draft Blower MIP but not on the Westinghouse Forced Draft Blower MIP.

Performing the lubrication action will ensure that the blower shutters will operate freely. This action will reduce the possibility that the shutters will remain open and allow forced draft air from an operating blower to drive a nonoperating blower backwards. Although the Attached Lube Oil Pump operates in both the forward and reverse directions, operation at low fan speed does not provide sufficient oil pressure to prevent journal bearing damage.

4.2.2.4 Inspection of Right-Angle Gear Drive Strainer

Recommendation

Develop an MRC to clean and inspect the strainers in the right-angle gear drive lube oil lines. The periodicity should be M (Monthly), while the estimated burden should be 0.1 man-hours (per blower). Add this MRC to the Westinghouse Blower MIP (F-2/101-B5).

Problem

There is no PMS requirement to clean or inspect the right-angle gear drive strainer. Plugged strainers limit oil flow to the gear drive and contribute to gear drive failures.

Explanation

ShipAlt FF-1052-113D has been installed on most of the Westinghouse Forced Draft Blowers of the FF-1052 Class. One major item in this ShipAlt is the installation of lube oil strainers in the lube oil supply lines to the right-angle gear drive sprayer nozzles. These strainers were installed to prevent the sprayer nozzles from clogging because of the accumulation of dirt in the lube oil system. If the strainers become plugged and limit oil flow to the nozzles, no oil will be supplied to the right-angle gear drive. Thus the gear failures the ShipAlt was developed to eliminate might still occur. However, gear failures can be reduced or eliminated by cleaning the strainers at regular intervals. NAVSEC has suggested that the strainers should be cleaned monthly until the Lube Oil System modifications are complete. After the Lube Oil System is modified, the periodicity should be extended, because the system will have greater filtration capability.

4.2.2.5 Cyclic Periodicity Changes

Recommendation

Change the periodicity of five Westinghouse Forced Draft Blower MRCs and six Hardie-Tynes Forced Draft Blower MRCs from Cyclic (every 36 months) to 54M (every 54 months).

Problem

Several system MRCs are normally scheduled for accomplishment during the ROH that occurs at the (nominal) 36-month point in the operating cycle. With an extended (54 month) operating cycle, the scheduling of these MRCs is not correct.

Explanation

The analysis of MDCS data showed that there were no significant replacements of parts associated with the cyclic maintenance actions, indicating that the corrective maintenance that would normally result from the cyclic inspections has not occurred. CASREPT analysis showed that only 9 percent of the reported CASREPTs are related to the cyclic inspections. Ship surveys indicated that the FF-1052 Class Forced Draft Blowers have not experienced any significant major maintenance of the type that would be associated with these cyclic inspection actions. The following MRCs should be changed from C (every 36 months) to 54M (every 54 months):

MRC Number	MIP Number	Forced Draft Blower
25-F93W-N	F-2/101-B5 and F-2/125-95	Westinghouse and Hardie-Tynes
B5-J28N-N	F-2/101-B5	Westinghouse
B5-J28P-N	F-2/101-B5	Westinghouse
45-G71Z-N	F-2/125-95	Hardie-Tynes
95-H85G-N	F-2/125-95	Hardie-Tynes
32-B26V-C	F-2/125-95	Hardie-Tynes
35-G33C-N	F-2/101-B5 and F-2/125-95	Westinghouse and Hardie-Tynes
MIP Entry C-11	F-2/101-B5 and F-2/125-95	Westinghouse and Hardie-Tynes

4.2.3 BOH Requirements

The rotating portions of both the Westinghouse and Hardie-Tynes Forced Draft Blowers have been shown to be basically reliable. It has also been shown that ancillary equipments have been the source of most of the maintenance problems. It is expected that the Forced Draft Blowers and their driving turbines will require some repair work during the Baseline Overhaul. However, it is not expected that these rotating equipments will need a complete overhaul at that time. The specific repairs required will be determined by inspection. Baseline Overhaul requirements are as follows:

- Repairs
  - Perform Class C repairs of four Forced Draft Blowers
  - Perform Class C repairs of two motor-driven Lighting-Off Blowers and associated Motors
- Modifications
  - Install ShipAlt FF-1052-113D -- Westinghouse Forced Draft Blower Modifications
  - Install ShipAlt FF-1052-201K -- Westinghouse Forced Draft Blower Steam Admission Valve Modifications
  - Install ShipAlt FF-1052-409D -- Hardie-Tynes Forced Draft Blower Steam Admission Valve Modifications

REFERENCES AND SOURCES OF INFORMATION

The specific sources of information used as the basis for the System Maintenance Analysis of the Combustion Air System are listed below.

Reference Number	Source
1	Trip Report (December 8-12, 1975); ARINC visit to COMNAVSURFPAC Staff, FF-1063, FF-1065, FF-1088, and DATC.
2	Generation III MDCS Part and Maintenance Data for DE/FF-1052 Class; for period 1 January 1970 through 31 December 1974.
3	CASREPTs for DE/FF-1052 Class for period 1 January 1970 through 31 December 1974.
4	Technical Manual - Main Forced Draft Blower (Westinghouse); NAVSHIPS 0953-009-7010 (15 December 1975).
5	Technical Manual - Main Forced Draft Blower (Hardie-Tynes, Inc.); NAVSHIPS 0953-003-0010 (30 October 1969).
6	Technical Manual - Lawler Temperature Regulating Valve; NAVSHIPS 0961-053-9010.
7	NAVSHIPS Technical Manual, Chapter 9530, "Blowers" (September 1967).
8	Operating Guides for Propulsion Machinery, NAVSHIPS 0906-006-8010, 0905-083-3010, 0905-130-1011.
9	Material Condition of FF-1052 Class Ships; Letter to Chief of Naval Operations from President, Board of Inspection and Survey; ltr 01B/mbs; FF-1052 Class; Ser C208, dated 23 October 1975 (CONFIDENTIAL).
10	Ship Alteration Record (NAVSEA 4720/4) for ShipAlts FF-1052-113D, 201K, 336D, 367D, 409D (dates as issued).

(continued)

Reference Number	Source
11	Material Maintenance Management (3M) Manual; OPNAVINST 4790.4, Volumes I, II, and III: dated June 1973.
12	Maintenance Index Pages (MIPs) for the Combustion Air System (various dates).
13	Maintenance Requirement Cards (MRCs) as listed on the Combustion Air System MIPs (various dates).
14	Type Commander's COSAL, SURFLANT (dated 19 May 1975) and SURFPAC (dated 19 August 1975).
15	Letter to NAVSEA 934 and PMS 301 from NAVSEC Code 6153B; 6153B5/HBB: 9251/FF1052C1: Ser 1251: 28 July 1976 - Subj: Forced Draft Blower Oil System Modification ShipAlt Proposal; includes enclosures.
16	Letter to NAVSEA PMS 301 from NAVSEC Code 6153B; 6153B5/HBB: 9251/ESR 6043016: Ser 648: 16 April 1976 - Subj: Boiler Light-Off/Port Use Fan and Butterfly Valves ShipAlt Proposal; includes enclosures.
17	Technical Repair Standard (0251-086-604) for Westinghouse Forced Draft Blower (APL 057800178) (Preliminary).
18	1200 PSI Propulsion Plant Test and Certification Manual; NAVSEA 0941-LP-053-6010, Appendix Nine, FF-1052 Class; Test Procedure 221F1010120 (Automatic Combustion Control) (1976).
19	1200 PSI Propulsion Plant Test and Certification Manual; NAVSEA 0941-LP-053-6010, Appendix Nine, FF-1052 Class; Test Procedure 251F4010060 (Combustion Air System) (1976).
20	1200 PSI Propulsion Plant Test and Certification Manual; USS TOWERS (DDG-9); 31 August 1973.

APPENDIX A

COMBUSTION AIR SYSTEM BOUNDARIES

This appendix presents the boundaries of the System Maintenance Analysis of the Combustion Air System. Figure A-1 is a schematic diagram of the system. Table A-1 is a listing of the equipments, by APL and applicable hull, that constitute the Combustion Air System.

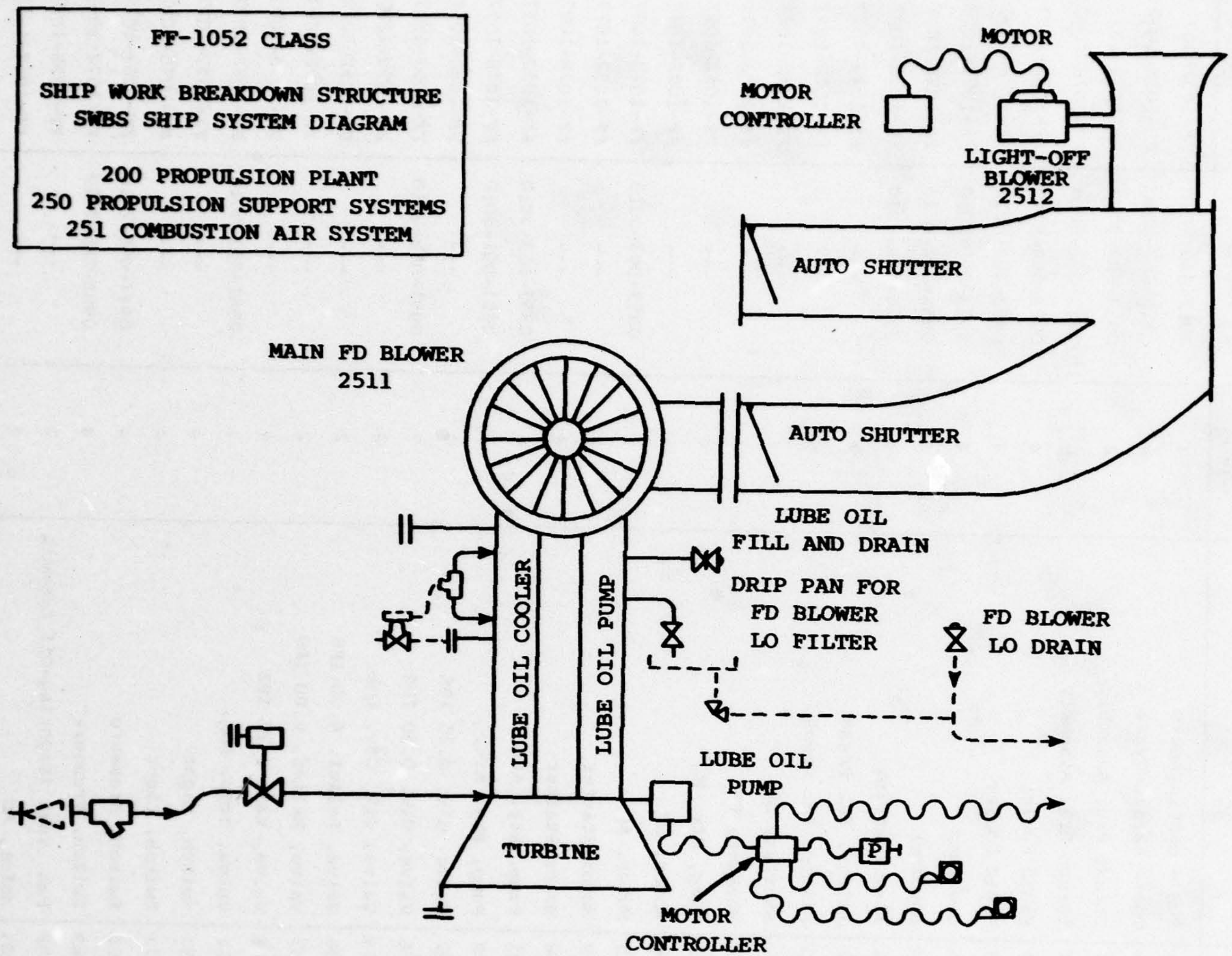

Figure A-1. COMBUSTION AIR SYSTEM

Table A-1. LISTING OF COMBUSTION AIR SYSTEM EQUIPMENTS				
APL/CID	Noun Name	Number per Ship	Technical Manual Number	Hull Applicability
057800178	FDB - Westinghouse	4	0953-009-7010	FF-1052-1077
057960029	FDB - Hardie-Tynes	4	0953-003-0010	FF-1078-1097
370010294	Thrust Brg. Assembly	4	0953-009-7010	FF-1052-1077
370030038	Thrust Brg. Assembly	4	0953-001-5010	FF-1078-1097
030250012	Fluid Cooler	4	0953-009-7010	FF-1052-1077
030130865	Fluid Cooler	4	0953-003-0010	FF-1078-1097
701110286	Governor	4	0953-009-7010	FF-1052-1077
701110320	Governor	4	0953-003-0010	FF-1078-1097
780130001	Flex Coupling	4	0920-024-1010	FF-1052-1097
480020181	Filter, Fd. Press.	4	---	FF-1052-1077
480060570	Filter, Fd. Press.	4	---	FF-1078-1097
400270041	Shutter, LH	2	---	FF-1052-1077
400270042	Shutter, RH	2	---	FF-1052-1077
016160559	Pump, Rty, MD	4	---	FF-1052-1077
174660624	Motor, AC	4	---	FF-1052-1077
174752615	Motor, AC	4	0953-003-0010	FF-1078-1097
151903459	Motor Starter	4	---	FF-1052-1077
151208668	Motor Starter	4	---	FF-1078-1097
017210101	Pump, Rty. Att.	4	0953-013-0010	FF-1052-1077
017210098	Pump, Rty. Att.	4	0953-001-5010	FF-1078-1097
882054952	Valve, Glb. 0.25 IPS	4	---	FF-1052-1077
882051966	Valve, Glb. 0.50 IPS	7	0961-053-9010	FF-1052-1077
883000359	Valve, Glb. Gov. Lnk.	4	---	FF-1078-1097
882241386	Valve, Relief, 6.00 IPS	2	---	FF-1052-1077
882241387	Valve, Relief, 6.00 IPS	2	---	FF-1052-1097
882095324	Valve, Red. 0.25 IPS	4	---	FF-1078-1097
882141722	Valve, Temp. Reg.	4	0961-053-9010	FF-1052-1097
212941353	Switch, Light	4	---	FF-1052-1077
212102573	Switch, Light	4	---	FF-1078-1097
610011566	Switch, Pressure	4	0947-096-7010	FF-1052-1077
610011569	Switch, Pressure	4	0961-020-7010	FF-1078-1097
400090258	Fan, Vnxl (Lighting-Off Blower)	2	---	FF-1052-1097
174751884	Motor, AC	2	---	FF-1052-1077
151207647	Motor Starter	2	0958-020-0010	FF-1052-1097
882291382	Valve, Butterfly Isolation, 18.00 IPS	2	---	FF-1052-1097

APPENDIX B

MDCS DATA SCREENING

A data screening process was used to identify equipments for analysis. The basic data source consisted of the MDCS data for the period 1 January 1970 to 31 December 1974. This data base includes the number of maintenance actions reported against particular equipments, date of occurrence, ship, associated APL, and codes related to the nature of the problem (e.g, when discovered, cause, action taken, etc.). Also included is information about the number of parts ordered, when ordered, the APL under which a part was ordered, cost per part, the ship for which a part was ordered, and part nomenclature. The data base was screened, along with configuration information and CASREPT and MDCS narratives, to identify corrective maintenance problems in the Combustion Air System for the FF-1052 Class ships. The screening process for the MDCS data was as follows:

1. Equipment APLs were screened by the number of ships reporting maintenance. This screening identified equipments for which ten or more ships reported maintenance.
2. Additional screening was performed to identify equipments that had large reported man-hour burdens or a large number of maintenance actions. An equipment that had a total reported burden of 50 man-hours and had reported 100 maintenance actions or more during the data period was selected for further analysis.
3. To identify significant replacement parts usage, three criteria were used:
   a. If a part was reported replaced on greater than 50 percent of the applicable ships, it was selected for analysis.
   b. If a part was reported on greater than 25 percent of the applicable ships and its replacement cost was greater than $10, it was selected for analysis.
   c. If the replacement cost for a part was greater than $500 and it was replaced on more than 10 percent of the applicable ships, it was considered, to be an "unusual" part and was selected for analysis, as an indication of major maintenance.

There are often three groups of equipments defined within the FF-1052 Class ships; some equipments are applicable to only one portion of the Class. These groupings occur because of the way

in which the ships were procured. Table B-1 lists the number of ships represented by the defined screening percentages for the three groups of ships.

Table B-1. NUMBER OF SHIPS REPRESENTED BY SCREENING PERCENTAGES

Screening Percentages (Percent of Ships)	Number of Ships by Ship Group		
	Total Class	Early Class	Late Class
10	5	3	2
25	11	6	5
50	23	13	10
60	27	15	12

4. Engineering judgment was also used to select equipments or individual parts for further analysis. In some cases screened-out parts were later included in the analysis if their replacement was a function of some identified equipment problem. Packing, gaskets, and associated fasteners were eliminated from study because these types of parts are considered consumables and are normally indicative of routine maintenance.

APPENDIX C

CASREPT ANALYSIS SUMMARY

One hundred forty-three Combustion Air System CASREPTs (Casualty Reports) submitted over the five-year data period were reviewed. The CASREPTs were grouped into nine general categories. The number of reports per category was determined in order to identify the relative significance of the category and to establish the ranking of problem areas. The results of this analysis are presented in Table C-1.

Table C-1. CASREPT ANALYSIS RESULTS

Category	Rank	Number of CASREPTs Submitted			Percent of Total	Number of Ships Reporting	
		Early Class	Late Class	Total		Early Class	Late Class
Steam Admission Valve	1	37	1	38	26	16	1
Attached Lube Oil Pump and Drive	2	23	2	25	17	16	2
Motor-Driven Lighting-Off Blowers	3	15	6	21	15	13	3
FDB Bearings and Mechanical Problems	4	15	2	17	12	10	1
FDB Governor	5	11	2	13	9	6	2
Miscellaneous Lubricating System Problems	6	2	6	8	6	4	1
FDB Miscellaneous Valves	7	7	1	8	6	4	1
Undefined Problems	8	8	0	8	6	6	0
Motor-Driven Lube Oil Pump	9	3	2	5	3	3	2
Totals	--	121	22	143	100	--	--

CASREPTs identified the Steam Admission Valve and Attached Lube Oil Pump and Drive as problem areas in the Combustion Air System for ships equipped with Westinghouse blowers. The motor-driven Lighting-Off Blower problems are applicable to ships equipped with both Westinghouse and Hardie-Tynes blowers. No other problem areas were identified. It should be noted, however, that the Late Class ships are newer and there are fewer maintenance data available for them. Other failures were evaluated and found not to represent significant problems.

APPENDIX D

SHIPALT SUMMARY

1. FF-1052-113D -- modifies the Westinghouse Forced Draft Blower by replacing the oil spray nozzles for the right-angle gear drive, replacing the existing relief valve spring with a 35-psi spring, installing a differential pressure gage across the lube oil filter, enlarging the governor coupling oil spray hole, and decreasing the O.D. of the valve drive linkage bearing housing.

2. FF-1052-201K -- removes the double-seated Steam Admission Valve on the Westinghouse Forced Draft Blowers and replaces it with a single-seated valve.

3. FF-1052-336D -- installs a differential pressure gage across the inlet and outlet of the Hardie-Tynes Forced Draft Blower lube oil filter. The pressure gage will indicate when the lube oil filter becomes clogged and needs replacement.

4. FF-1052-367D -- provides for the installation of four additional inspection holes in the lube oil sumps of the Westinghouse Forced Draft Blowers. The inspection holes will provide better access for cleaning the lube oil sump.

5. FF-1052-409D -- modifies the Steam Admission Valves on the Hardie-Tynes Forced Draft Blowers to provide better low-speed control of the blower and reduce steam-cutting of the valve body.

6. Proposed "Boiler Light-Off/Port Use Fan and Butterfly Valves" -- modifies the Lighting-Off/Port Use Motor-Driven Forced Draft Blower so that the position of the Butterfly Valves (blower isolation valves) can be determined from the operating station. See NAVSEC Code 6153B letter to PMS 301, Ser 648, 16 April 1976 (Reference 16).

7. Proposed "Westinghouse Forced Draft Blower Lube Oil System Modifications" -- improves the lubrication and oil temperature control for the Westinghouse Forced Draft Blower. In addition, it would provide automatic start-up of the motor-driven lube oil pump on low pressure. See NAVSEC Code 6153B letter to NAVSEA 934 and PMS 301, Ser 1251, 28 July 1976 (Reference 15).

APPENDIX E

DDEOC MRC EVALUATION

This appendix specifies the Maintenance Index Pages (MIPs) applicable to the Combustion Air System. In addition, the DDEOC MRC Evaluation form lists the Maintenance Requirement Cards (MRCs) that should be modified or deleted and indicates needs for new MRCs.

Table E-1 lists the MIPs applicable to the FF-1052 Class Combustion Air System.

Table E-1. COMBUSTION AIR SYSTEM MIP APPLICABILITY

Equipment	Ship Group	MIP Number
1. Westinghouse Forced Draft Blower	Early	F-2/101-B5
2. Hardie-Tynes Forced Draft Blower	Late	F-2/125-95
3. Motor-Driven Lighting-Off Blower	Total	F-2/118-BO
4. Lighting-Off Blower Motor	Total	EL-4/28-C4
5. Motor Controllers	Total	EL-3/25-C4

The DDEOC MRC Evaluation form lists the MRCs that required changes and specify requirements for developing new MRCs. The column headings of the form are explained as follows:

- MRC Title - Description of maintenance specified by MRC
- MRC Number - Identification number of MRC
- Responsibility - Organizations responsible for change (if any)
- Current Status - (Self-explanatory)
- Man-Hours - Personnel-time burden allotted to complete maintenance action
- Frequency - When the MRC maintenance action is to be performed, e.g., D = Daily, W = Weekly, M = Monthly, C = Once every cycle, etc.

* Type - Perform maintenance (P), or survey material condition of component (S)
* Who Performs Test - Maintenance action or test to be performed by tender, or DDEOC Field Site Team, or Ship's Force personnel
* Where Performed - (Self-explanatory)
* Data - Indicates whether data are recorded during performance of maintenance action

DDEOC MRC EVALUATIO

MRC TITLE	MRC NUMBER	RESPONSIBILITY		CURRENT STATUS			MAN-HOURS		FREQUENCY	
		NAVSEA	DDEOC	OLD WITH NO CHANGE	OLD WITH REVISION	NEW	PRE-DDEOC M/H	POST-DDEOC M/H	PRE-DDEOC	POST-DDEO
MAIN FORCED DRAFT BLOWER										
MIP F-2/101-B5										
1. Measure clearance between fan blade tips and casing	B5-J28L-N		X		X		1.0	0.0	S	-
2. Lubricate Forced Draft Blower shutters and counterweight operating mechanism	C1-A93L-Q		X	X			0.3	0.3	Q	Q
3. Clean, inspect, and preserve exterior of turbine casing	25-F93W-N		X		X		3.0	3.0	C	54M
4. Inspect shaft journals, bearing, seal rings, and labyrinth packing; measure clearances	B5-J28N-N		X		X		77.0	77.0	C	54M
5. Deliver oil cooler to repair facility for cleaning and repair	B5-J28P-N		X		X		5.0	5.0	C	54M
6. Clean and inspect turbine steam strainer	35-G33L-N		X		X		1.0	1.0	C	54M
7. Request repair activity to inspect casing, turbine wheels, etc.	MIP Entry C-11		X		X		-	-	C	54M
8. Clean and inspect right-angle gear drive lube oil strainer	To be assigned		X			X	-	0.1	-	M
MAIN FORCED DRAFT BLOWER										
MIP F-2/125-95										
1. Test blower shutters for leakage	B5-J28M-N		X	X			1.0	1.0	A	A
2. Clean, inspect, and preserve exterior of turbine casing	25-F93W-N		X		X		3.0	3.0	C	54M
3. Inspect labyrinth packing	45-G71Z-N		X		X		12.0	12.0	C	54M
4. Inspect main bearings, journals, and oil seals; measure clearances	95-H85G-N		X		X		15.0	15.0	C	54M
5. Deliver lube oil cooler to repair facility for cleaning and testing	32-B26V-C		X		X		5.0	5.0	C	54M
6. Clean & inspect turbine steam strainer	35-G33C-N		X		X		1.0	1.0	C	54M
7. Request repair activity to inspect casing, turbine nozzles, etc.	MIP Entry C-11		X		X		-	-	C	54M

*P = PERFORM MAINTENANCE; S = SURVEY INSPECTION

MRC EVALUATION

RS	FREQUENCY		TYPE*	WHO PERFORMS TEST			WHERE PERFORMED	DATA	REMARKS
ST-DDEOC M/H	PRE-DDEOC	POST-DDEOC	P-PERF. S-SURV.	TENDER	DDEOC	SHIP	I-IN PORT S-AT SEA	YES NO	
									Westinghouse (APL 057800178)
0.0	S	-	S			X	I,S	Yes	Delete this MRC
0.3	Q	Q	P			X	I,S	No	Add this MRC to Westinghouse Blower MIP
3.0	C	54M	P			X	I,S	No	
7.0	C	54M	S	X		X	I	Yes	
5.0	C	54M	P	X		X	I	No	
1.0	C	54M	P,S			X	I	No	
-	C	54M	P			X	I	No	
0.1	-	M	P			X	I,S	No	
									Hardie-Tynes (APL 057960029)
1.0	A	A	S			X	I,S	No	Add this MRC to Hardie-Tynes Blower MIP
3.0	C	54M	P			X	I	No	
12.0	C	54M	S	X		X	I	No	
15.0	C	54M	S	X		X	I	Yes	
5.0	C	54M	P			X	I	No	
1.0	C	54M	P,S			X	I	No	
-	C	54M	P			X	I	No	

APPENDIX F

PMS BURDEN CHANGES

The changes to the PMS maintenance requirements alter the planned maintenance burden for both the Westinghouse and Hardie-Tynes Forced Draft Blowers. The burden change and resulting savings are a function of the deletion of requirements, the addition of requirements, and the change in periodicity of requirements. The savings are expressed as follows:

Savings = Deletions + Changes* - Additions

Each FF-1052 Class ship uses four Forced Draft Blowers to provide combustion air to the boilers. Twenty-six hulls (hulls FF-1052 through FF-1077) have Westinghouse blowers installed, while twenty hulls (hulls FF-1079 through FF-1097) have Hardie-Tynes blowers installed.

1. WESTINGHOUSE FORCED DRAFT BLOWER

The changes in the Westinghouse Forced Draft Blower PMS requirements result in the following burden modifications:

- Deletions - MRC B5-J28L-N, 2.0 man-hours/blower/year
  - = 8.0 man-hours/ship/year
  - = (8.0 man-hours/ship/year) × (26 ships) × (4.5 years/54-month cycle)
  - = 936 man-hours/all Westinghouse blowers/54-month cycle
- Additions
  - •• MRC C1-A93L-Q, 0.3 man-hours/blower/quarter
    - = 4.8 man-hours/ship/year
    - = (4.8 man-hours/ship/year) × (26 ships) × 4.5 years/54-month cycle)
    - = 562 man-hours/all Westinghouse blowers/54-month cycle

*It should be noted that changes can be either plus (+) or minus (-).

•• New MRC (Clean and Inspect Right-Angle Gear Drive Strainer), estimated burden: 0.1 man-hours/blower/month

= 0.4 man-hours/ship/month

= 4.8 man-hours/ship/year

= 562 man-hours/all Westinghouse blowers/54-month cycle

•• Total Additions: (562 + 562) man-hours/all Westinghouse blowers/ 54-month cycle

= 1124 man-hours/all Westinghouse blowers/54-month cycle

• Changes

MRC	Man-Hour Burden	Man-Hour/Year (Cyclic)	Man-Hour/Year (54M)
25-F93W-N	3.0	1.0	0.7
B5-J28N-N	77.0	25.7	17.1
B5-J28P-N	5.0	1.7	1.1
35-G33C-N	1.0	0.3	0.2
C-11	---	---	---
Totals		28.7	19.1

Difference = 9.6 man-hours/blower/year

The resulting savings for all Westinghouse blowers caused by periodicity changes is 9.6 man-hours/blower/year

= 38.4 man-hours/ship/year

= (38.4 man-hours/ship/year) × (26 ships) × (4.5 years/54-month cycle)

= 4493 man-hours/all Westinghouse blowers/54-month cycle

• Total Savings = 936 man-hours/all Westinghouse blowers/54-month cycle

+ 4493 man-hours/all Westinghouse blowers/54-month cycle

- 1124 man-hours/all Westinghouse blowers/54-month cycle

= 936 + 4493 - 1124

= 4305 man-hours/all Westinghouse blowers/54-month cycle

= (4305 man-hours/all Westinghouse blowers/54-month cycle) ÷ (26 ships/all Westinghouse blowers)

= 166 man-hours/ship/54-month cycle

Thus the recommended PMS changes will save about 166 man-hours per ship over the 54-month operating cycle for ships with the Westinghouse Forced Draft Blowers.

2. HARDIE-TYNES FORCED DRAFT BLOWER

The changes in the Hardie-Tynes Forced Draft Blower PMS requirements result in the following burden changes:

- Deletions - None
- Additions - MRC B5-J28M-N, 1.0 man-hours/blower/year

  = 4.0 man-hours/ship/year

  = (4.0 man-hours/ship/year) × (4.5 years/54-month cycle)

  = 360 man-hours/all Hardie-Tynes blowers/54-month cycle
- Changes

MRC	Man-Hour Burden	Man-Hour/Year (Cyclic)	Man-Hour/Year (54M)
25-F93W-N	3.0	1.0	0.7
45-G71Z-N	12.0	4.0	2.7
95-H85G-N	15.0	5.0	3.3
32-B26V-C	5.0	1.7	1.1
35-G33C-N	1.0	0.3	0.2
C-11	---	---	---
Totals		12.0	8.0

Difference = 4.0 man-hours/blower/year

The resulting saving for all Hardie-Tynes blowers caused by periodicity changes is 4.0 man-hours/blower/year.

= 16.0 man-hours/ship/year

= (16.0 man-hours/ship/year) × (4.5 years/54-month cycle)

= 1440 man-hours/all Hardie-Tynes blowers/54-month cycle

- Total Savings = (0 + 1440 - 360) man-hours/all Hardie-Tynes blowers/54-month cycle

  = 0 + 1440 - 360

  = 1080 man-hours/all Hardie-Tynes blowers/54-month cycle

  = (1080 man-hours/all Hardie-Tynes blowers/54-month cycle) ÷ (20 ships/all Hardie-Tynes blowers)

  = 54 man-hours/ship/54-month cycle

Thus the recommended PMS modifications will save about 54 man-hours per ship over the 54-month operating cycle for ships with the Hardie-Tynes Forced Draft Blowers.

APPENDIX G

DDEOC ACTION TABLE

This appendix summarizes action information for each of the recommendations discussed in this report.

DDEOC ACTION TA

1 ACTION ITEM* a. NO.	b. TITLE	2 DDEOC EVALUATION**	3 ACTION ITEM DESCRIPTION	4 REPORT REFERENCE (PARA.)	5
1.	Lube Oil System ShipAlt Proposal (Westinghouse)		Develop ShipAlt from NAVSEC proposal and install		SEC 934
2.	Lighting-Off Blower Ship-Alt Proposal (Westinghouse and Hardie-Tynes)		Develop ShipAlt from NAVSEC proposal and install		SEC 934
3.	Lube Oil Pump Drive Gears (Westinghouse)		Install ShipAlt FF-1052-113D at BOH		TYC
4.	Steam Admission Valve (Westinghouse)		Install ShipAlt FF-1052-201K at BOH		PMS
5.	Steam Admission Valve (Hardie-Tynes)		Install ShipAlt FF-1052-409D at BOH		TYC
6.	PMS Changes				
6A.	Propeller Clearance Check		Delete MRC B5-J28L-N from MIP F-2/101-B5 (Westinghouse)		SEA
6B.	Shutter Leakage		Add MRC B5-J28M-N to MIP F-2/125-95 (Hardie-Tynes)		SEA
6C.	Shutter Lubrication		Add MRC C1-A93L-Q to MIP F-2/101-B5 (Westinghouse)		SEA
6D.	Forced Draft Blower Inspections		Extend the periodicity of the following MRCs from Cyclic to 54M: 1. 25-F93W-N (W & H-T) 2. B5-J28N-N (W) 3. B5-J28P-N (W) 4. 35-G33C-N (W & H-T) 5. MIP Entry C-11 (W & H-T) 6. 45-G71Z-N (H-T) 7. 95-H85G-N (H-T) 8. 32-B26V-C (H-T)		SEA
6E.	Lube Oil Pump Gear Drive Strainers		Develop an MRC to clean and inspect the Lube Oil Pump Gear Drive lube oil strainers. Add it to MIP F-2/101-B5. (Westinghouse)		SEA

* NOTE 1: DEVELOPING ACTIVITY FILL IN THE FOLLOWING BLOCKS: 1a, b; 3; 4; 5 (IF KNOWN); 6a, IF REQUIRED FOR CONTINUATIC

** NOTE 2: DDEOC EVALUATION – APPROVED, FURTHER STUDY REQ'D, ETC.

† NOTE 3: RESPONSIBILITY – NAVSEC, NAVSEA, NSRDC, ETC.

OC ACTION TABLE

4. REPORT REFERENCE (PARA.)	5. RESPONSIBILITY †	6. SCHEDULING DATES a. REQD.	b. START	c. COMP.	7. REMARKS, FUNDING IMPLICATIONS, ETC.	8. ACTUAL ACTION TAKEN
	SEC 6153B, SEA 9342				See 6153B letter, Ser. 1251, 28 July 1976	
	SEC 6153B, SEA 9342				See 6153B letter, Ser. 648, 16 April 1976	
	TYCOM					
	PMS-301					
	TYCOM					
	SEA 04					
	SEA 04					
	SEA 04					
	SEA 04					
					NOTE: (W) = Westinghouse (H-T) = Hardie-Tynes	
	SEA 04					

FOR CONTINUATION OF DEVELOPING ACTIVITY TASK; 7, AS NECESSARY.